DRAFT

2009 Connecticut GHG Inventory Update

1.0 Introduction:

Public Act 08-98, An Act Concerning Connecticut Global Warming Solutions (GWSA) established mandatory greenhouse gas (GHG) emission reduction requirements targets (Table 1). The reduction targets are 10% below 1990 levels by 2020 and 80% below 2001 levels by 2050. Although not part of the GWSA, the 2005 Connecticut Climate Change Action Plan (CCAP) contains a short term goal of returning to 1990 GHG emission levels by 2010. The GWSA also directed the Department of Environmental Protection (DEP) to publish an inventory of GHG emissions and establish a baseline for the GHG emission reductions required by the GWSA. In accordance with the GWSA, the DEP entered into a contract with Northeast States for Coordinated Air Use Management (NESCAUM) to examine previous approaches utilized by DEP in preparing the 2003 and 2006 GHG Inventories, to evaluate current GHG inventory approaches and methodologies utilized within the region and nationally and to determine if any changes or improvements were necessary to the DEP's methodologies.

NESCAUM assessed Connecticut's GHG inventory needs in the context of data availability, existing programs, and proposed/future programs at the State, Regional, and National level. As a result of their review, NESCAUM found a lack of common "bottom-up" approaches in the Northeast region, and widespread adoption of "top-down" tools such as the State Inventory Tool (SIT) developed by the Environmental Protection Agency (EPA). NESCAUM validated DEP's approach to developing a GHG inventory and recommended DEP continue development of a "top-down" inventory based on the EPA SIT. In addition, NESCAUM identified several areas where more specific data could be developed, however this data reflected a small portion of overall GHG emissions in Connecticut. NESCAUM's final report is contained in Appendix C.

1.1 Overview

This inventory quantifies anthropogenic GHG emissions from within the borders of the State of Connecticut. The GHG's of interest are Carbon Dioxide (CO_2), Methane (CH4), Nitrous Oxide (N2O), Hydrofluorocarbons (HFC), Perfluorocarbons (PFC), and Sulfur Hexafluoride (SF6). Approximately 90% of all anthropogenic GHG emissions in Connecticut (CO_2, CH4, and N2O) are the result of fossil fuel combustion, related to transportation, space heating and electricity generation. The remaining 10% of anthropogenic GHG emissions in Connecticut (HFC, PFC, and SF6) are fluorinated compounds used in industrial processes. .

Table 1 below contains a summary of Connecticut's annual GHG emissions for 2007 and establishes base year emissions for 1990 and the mid-term target of 2020 as required by the GWSA. Although not part of

the GWSA, the 2005 CCAP contained a short-term goal of returning to 1990 emissions by 2010. As of 2007, Connecticut GHG emissions exceeded 1990 base year emissions by 4%. Part of this overage is attributable to changes in methodologies, such as increased use and reporting of Hydrofluorocarbons (HFC) following widespread adoption of the Montreal Protocol on Substances That Deplete the Ozone Layer beginning in 1996.

Table 1 – Summary of Connecticut GHG Annual Emissions and Targets

Greenhouse Gas Emissions/Targets	MMTCO2e
1990 Gross GHG Emissions	44.30
2020 Target (10% Below 1990)	39.90
2001 Gross GHG Emissions	46.50
2050 Target (80% Below 2001)	9.30
2007 gross GHG Emissions	46.10
2005 CCAP 2010 Goal	44.30

While the bulk of the inventory is complete between 1990 and 2007, several sections of the United States Environmental protection Agency's (EPA) State Inventory Tool (SIT) have not been updated past 2006. Gross GHG data is analyzed through the 1990 to 2006 time period only, while fossil fuel combustion data through 2007 is used where appropriate. The DEP expects data completeness issues to be resolved in 2010.

1.2 Methodology

Emissions inventories can be developed by direct measurement of emissions from point sources, or by analysis of activity data. In the case of GHG emissions there is a lack of direct GHG emissions monitoring, but there is reliable indicators of activity (such as, fuel use, and industrial and agricultural activity) that has been collected in a consistent manner. Many States, including Connecticut, have utilized the SIT to generate inventories of annual GHG emissions. EPA created the SIT to assist states in developing consistent and accurate assessments of their GHG emissions. The SIT is one of a class of inventory tools utilizing a "top down" methodology, which is based on large scale consumption data. The top-down approach provides a high degree of coverage of GHG emissions activity, but contains limited "bottom up" data (individual sources). While Connecticut continues to develop "bottom up" data for sources participating in permit and tracking programs, the data is not of sufficient quantity to develop a comprehensive GHG inventory for Connecticut.

The SIT provides an overview of GHG emissions both as a statewide gross emissions, statewide net emissions, and emissions on a sector-by-sector basis, beginning in 1990 through the year of latest data availability (typically 2007). Data sources for the SIT include the United States Energy Information Administration (EIA), United States Department of Energy (DOE), United States Department of Agriculture (USDA), United States Department of Transportation (USDOT), Connecticut Department of Transporta-

tion (CTDOT), and United States Census Bureau. These sources provide annual data of high quality, resulting in a consistent methodology for GHG and activity calculations. Statewide net GHG emissions are derived from the combination of all emissions and all GHG sinks (activity associated with GHG uptake). Land Use Change and Forestry (LUCF), owing to the various methods used to estimate aforestation, deforestation, agricultural land use, and land use conversion, is generally believed to be a source of GHG uptake, a "sink" of greenhouse gases, and results in a lower net GHG emissions if factored in to the total.

This inventory addresses gross GHG emissions, CO_2 from fossil fuel combustion (CO2FFC). LUCF data is addressed separately(Section 3.5). Figures 6 through 19 are available in Appendix A. A tabular summary of the annual data for gross GHG emissions and emissions from fossil fuel combustion is available in Appendix B.

1.3 Measurement

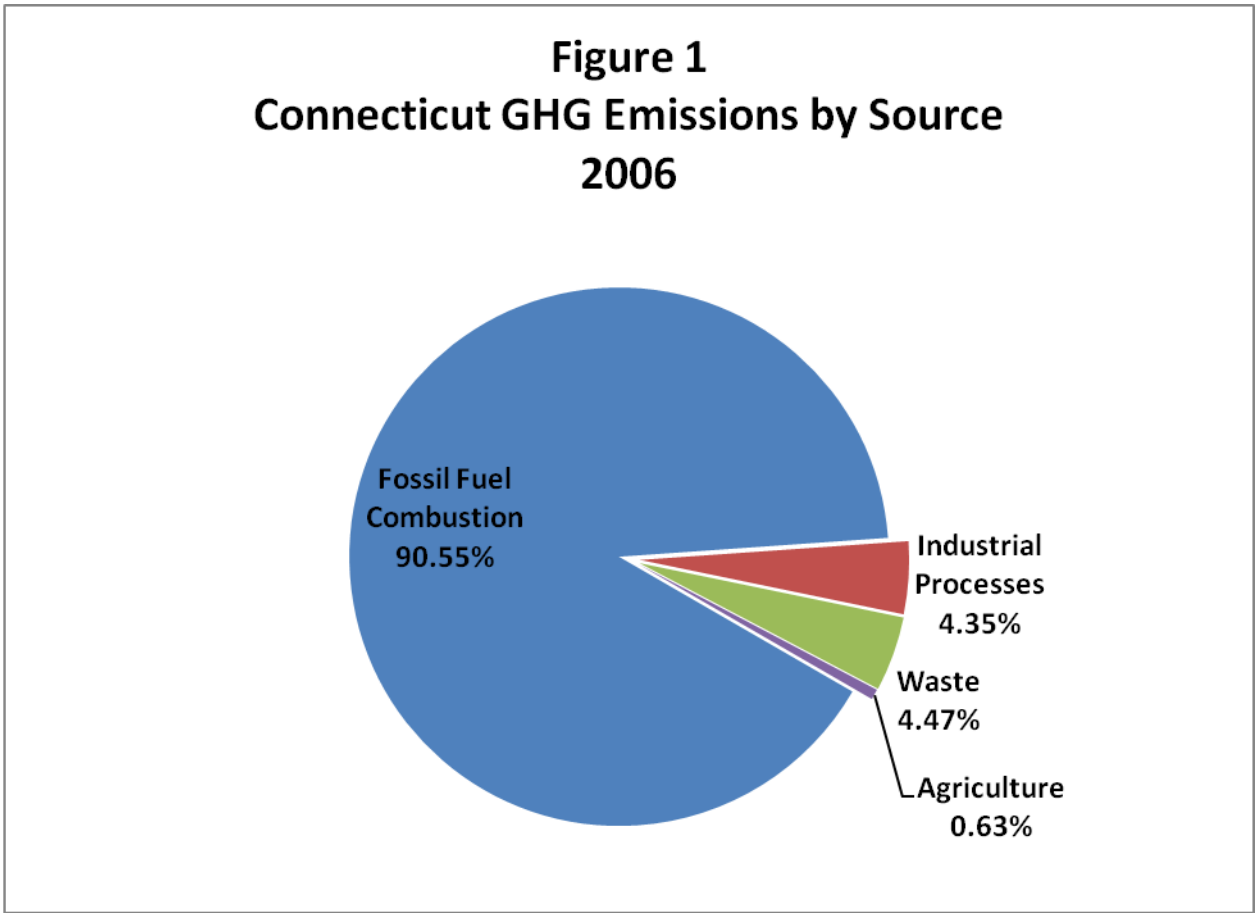
Greenhouse gas emissions are expressed in units of Carbon Dioxide (CO_2), or Carbon Dioxide Equivalent (CO2e). GHG emissions are measured based on a variety of activity data, and the activity is converted to a GHG emission total through the use of Emission Factors. These factors convert quantities of fuel use, energy generation, energy consumption, or other activity data into an equivalent CO_2 emissions level expressed in metric tons (1000 kilograms, or 2,204 pounds). Non-CO_2 GHGs have been assigned Global Warming Potential (GWP) values, expressed by equivalent quantities of CO_2 (CO2e). For example, one metric ton of Methane (CH4), with a GWP of 21, is equivalent to 21 metric tons of CO2e. Much of the data in this report is expressed as Million Metric Tons of CO_2 (MMTCO2) or Million Metric Tons of CO_2 Equivalent (MMTCO2e).

2.0 Statewide Emissions 1990 – 2007

Connecticut's statewide GHG emissions are linked to energy consumption. Carbon dioxide (CO_2) emissions related to the combustion of fossil fuels make up approximately 92% of overall statewide GHG emissions (see Figure 1). These GHG emissions are derived from combined fossil fuel consumption in the Residential, Commercial, Industrial, Transportation and Electric Power Generation sectors (Figure 3, Figure 4).

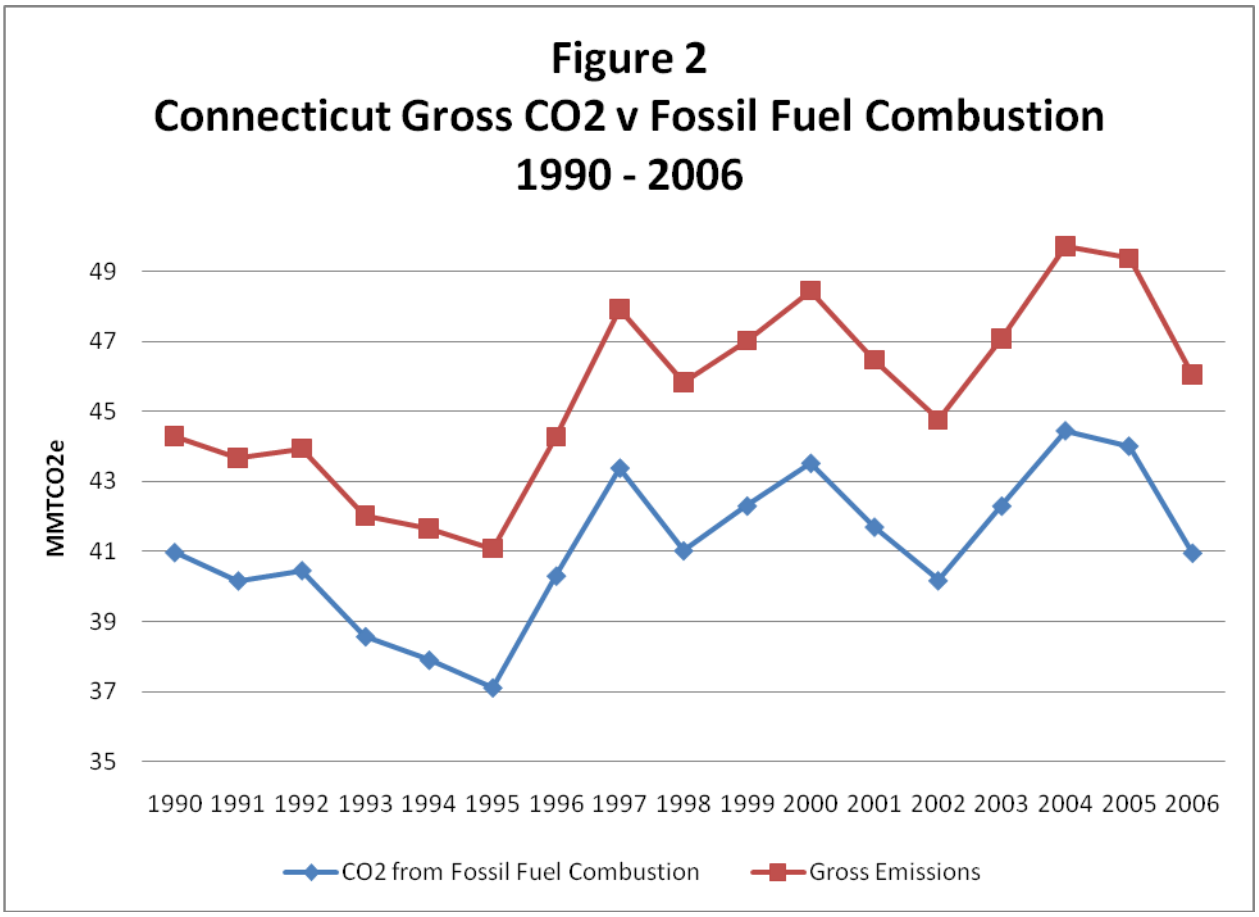
Table 2: Global Warming Potentials

Greenhouse Gas (GHG)	Global Warming Potential (GWP)
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
Hydrofluorocarbons (HFCs)	140 – 11,700
Perfluorocarbons (PFCs)	6,500 - 9,200
Sulfur Hexafluoride (SF_6)	23,900



2.1 Baseline Conditions

The GWSA requires that DEP utilize 1990 as the base year from which to identify required emission reduction targets. As such, a 1990 baseline is central to Connecticut's GHG inventory process. While 1990 is a baseline year for Connecticut and many other GHG Inventory programs, the 1990 base year does not hold any programmatic significance. According to the most recent version of the EPA SIT (September 2009) Connecticut's gross GHG emissions for 1990 was 44.3 MMTCO2e. In 2006, the last year for which complete SIT data is available, the total has increased to 46.1 MMTCO2e (Figure 2). In 2007, emissions from fossil fuel combustion have returned to the 1990 level of 41 MMTCO2e. 2006 Emissions from the Industrial Processes and Waste sectors (Figures 14 and 15) have increased from 1.9 to 4.1 MMTCO2e (an increase of 115% as compared to the 1990 base year).



3.0 Sector Summaries

The EPA SIT attributes GHG emissions based on the type of activity and the emissions related to that activity (Figure 3, Figure 4). Each activity type falls under a broad "sector". The sector divisions used in this report are: Electric Power, Transportation, Residential, Industrial and Commercial, and land Use Change/Forestry (LUCF).

Figure 3
ConnecticutFossil Fuel Combustion CO2 by Sector
1990 - 2007

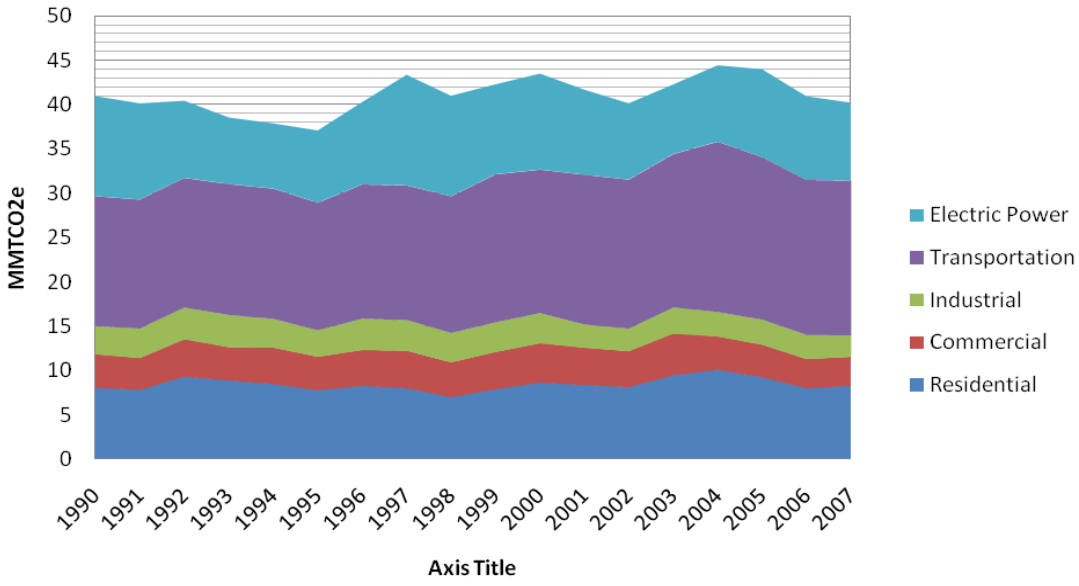
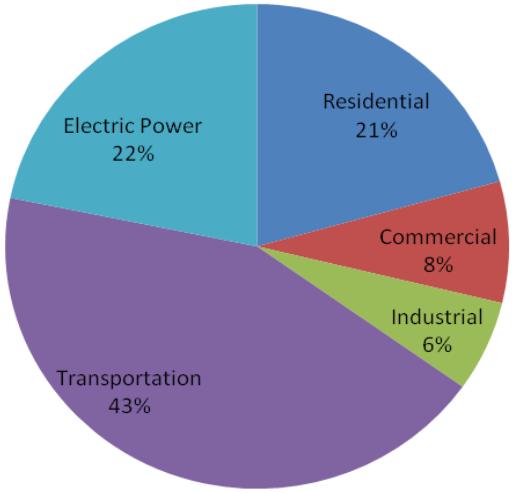


Figure 4
Connecticut CO2 from Fossil Fuel Combustion
2007



3.1 Electric Power Sector: 22 % of 2007 Connecticut GHG emissions

GHG emissions from electric power generation (Figure 6, Figure 7) in Connecticut are directly related to the type and quantity of fuel burned by electricity generating units. Since Connecticut is part of the regional power grid controlled by ISO-NE, these emissions are also dependent the dispatch of generating units located in all 6 NE states.

The reliable operation of the New England electricity grid requires the dispatch of EGUs as directed by ISO-NE. Given that electricity may be imported into or exported from Connecticut, EGU related emissions may not correspond completely to the amount of power consumed in Connecticut. The GHG data for Connecticut is based on reported fuel consumption as monitored by the United States Department of Energy (DOE) and the United States Energy Information Administration (EIA). Fossil fuel comprises only a portion of the electricity generated in Connecticut and within the ISO New England region. In addition, Nuclear and Hydroelectric power will contribute approximately 25.2% of the total capacity in the region in 2009.

3.2 Transportation Sector: 43 % of 2007 Connecticut GHG emissions

Gasoline and diesel fuel consumption accounts for the bulk of transportation related emissions noted in Figure 8. Emissions of CO_2 are directly related to the quantity of fuel consumed, while N2O and CH4 emissions are more variable due to the use of control technology. The trend of increased CO2 emissions (increased consumption of fossil fuel) in the transportation sector follows a similar increase in motor vehicle use (Figure 9) as measured in Vehicle Miles Traveled (VMT). Fuel consumption data from 2005 through 2007 indicates a reduction in motor vehicle use, while the VMT estimates (Connecticut Department of Transportation) show a level or slightly increasing use pattern. At the present time the disparity exists in the most recent data and may be subject to revision in future releases of VMT or fuel consumption data. The DEP hopes to verify or reconcile this disparity as better data becomes available.

3.3 Residential Sector: 21 % of 2007 Connecticut GHG emissions

GHG emissions from residential activity are largely related to space heating. Connecticut relies heavily on heating oil, with about half of Connecticut households using it as their primary source of heating fuel. Natural gas and electricity make up 44%, and small amounts of propane, and other fuels comprise the balance (2000 Census data). Figure 10 shows the proportion of Connecticut's Residential CO2 emissions by fuel used. Petroleum fuel consumption contributes approximately 75% of the CO2 emissions from the residential sector, with Natural Gas accountable for the remainder, and trace amounts of coal reported as used in residential applications. Figure 11 illustrates N2O and CH4 emissions from residential sources. These are based on combustion byproducts and account for approximately 1% of overall residential CO2e emissions.

3.4 Industrial/Commercial Sector: 14 % of 2007 Connecticut GHG emissions

The industrial sector generates GHG emissions from activities such as fossil fuel combustion, space heating, loss of HFC and PFC compounds, consumption of SF6, and methane emissions from waste treat-

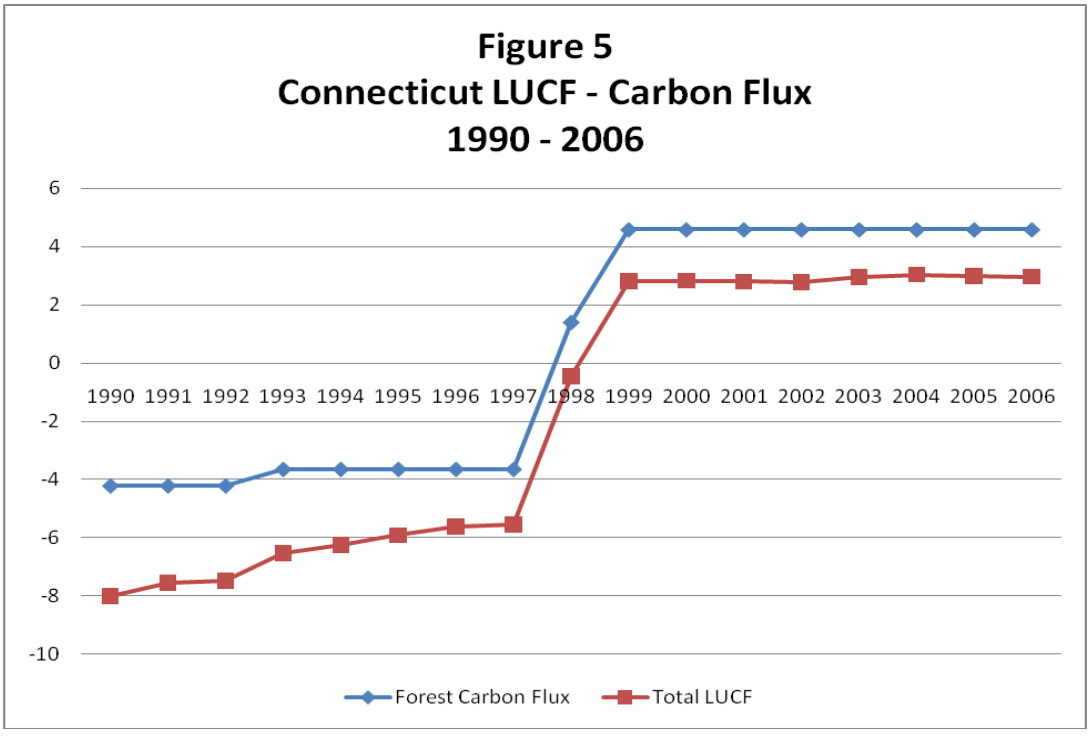
ment. GHG emissions related to electricity use are not considered as they are accounted for by the generation facility. On-site electricity generation is accounted for as a fuel consumption process and is not considered in this section.

GHG Emissions from the Industrial and Commercial sectors are illustrated in Figures 12 through 17 in Appendix A.

While the data shows no significant increase in emissions from the Industrial and Commercial sector, Industrial Process emissions have increased from less than 0.5 MMTCO2e prior to 1997, to greater than 2.0 in 2004 to 2006. This increase may be due to an increase in the use of HFCs and PFCs in place of Freon and other Ozone Depleting Substances (ODS) following widespread adoption of the Montreal Protocol on Ozone Depleting Substances in the mid-1990s.

3.5 Land Use Change/Forestry Sector: 0% of 2007 Connecticut GHG emissions

Land Use Change and Forestry (LUCF) is the only sector that is capable of negative GHG emissions (it can be a GHG sink rather than a GHG source). In addition to GHG emissions from fertilizer use, tillage, and composting, LUCF includes aforestation and other changes in land use that result in CO_2 uptake and storage. The effect can be an overall net negative CO_2 emissions rate for this sector. While the impact of this sector on Statewide emissions has the potential to account for as much as 10% of the total Connecticut GHG Inventory, the available data is of lower quality than comparable data on fuel consumption or industrial processes.



Changes in methodology and reporting between 1997 and 1999 created a significant change in the data, which result in net GHG emissions data from this source category. Figure 16 illustrates the effects of changing methodologies in the SIT with regard to forest carbon flux. With no known causal change in actual conditions to accompany it, the change from 1997 to 1999 (over 200% increase) is indicative of a change in source data or methodology as opposed to an actual increase in LUCF related GHG emissions. No event or series of events can explain the shift from a steady state of sequestration to a steady state of net emissions increase over such a short period of time. Based in large part on this historical dichotomy, NESCAUM identified the Land Use and Forestry sector as an area where significant improvements to the SIT can be made as part of a State or Regional effort.